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GP 2631

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

IN THE APPLICATION OF	)
	)
Simon Daniel Brueckheimer et al.	) Group Art Unit No. 5611
	)
SERIAL NO: 09/509,089	)
	)
FILED: March 21, 2000	)
	)
FOR: Transporting Multiprotocol Datagrams	)

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Dear Sir:

Under the International Convention, for the purposes of priority, applicant claims the benefit of United Kingdom Application No. 9720130.5, filed September 22, 1997.

A certified copy of said application is appended hereto.

DATE: August 17, 2001

Respectfully submitted,

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I also certify that the attached copy of the request for grant of a Patent (Form 1/77) bears an amendment, effected by this office, following a request by the applicant and agreed to by the Comptroller-General.

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Dated: 14-6-01.

GB9720130.5.

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NORTEL NETWORKS CORPORATION,
Incorporated in Canada,
World Trade Center of Montreal,
380 St Antoine Street West,
8th Floor,
Montreal,
Quebec,
H2Y 3Y4,
Canada

[ADP No. 07651656001]

Patents Form 1/77

1/77

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Patent
Office

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Statement of inventorship and of right to grant of a patent

The Patent Office

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Newport
Gwent NP9 1RH

1. Your reference
S D Brueckheimer et al 25 ID 0836

2. Patent application number
(The Patent Office will fill in this part)
9720130.5
22 SEP 1997

3. Full name, address and postcode of the or of each applicant (*underline all surnames*)
Northern Telecom Limited
World Trade Center of Montreal
380 St. Antoine Street West
8th Floor
Montreal
Quebec H2Y 3Y4
Canada

SECTION 32 (1977 ACT) APPLICATION FILED 25/5/99

THE PATENT OFFICE B 22 SEP 1997 LONDON

Patents ADP number (*if you know it*)

If the applicant is a corporate body, give the country/state of its incorporation
Quebec, Canada

4. Title of the invention
TRANSPORTING MULTIPROTOCOL DATAGRAMS

5. Name of your agent (*if you have one*)
John Peter William Ryan

"Address for service" in the United Kingdom to which all correspondence should be sent (including the postcode)
Nortel Patents
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Harlow, Essex
CM17 9NA

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Country	Priority application number (*if you know it*)	Date of Filing (*day/month/year*)

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Request for substantive examination (*Patents Form 10/77*)	
Any other documents (*please specify*)	

11.

I/We request the grant of a patent on the basis of this application.

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Date 22/9/97

J P W Ryan - Agent for the Applicants

12. Name and daytime telephone number of person to contact in the United Kingdom — J P W Ryan 01279 405679

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ID0836

TRANSPORTING MULTIPROTOCOL DATAGRAMS

This invention relates to a system and method for the transport of multiprotocol datagrams over an ATM network. The invention further relates to an improved point to point protocol.

BACKGROUND OF THE INVENTION

The current point to point protocol (PPP) provides a common standard for transporting multi-protocol datagrams over a point-to-point link. It provides the features of encapsulation, link configuration, maintenance, and authentication. PPP is used in many applications. In particular, the protocol has found significant usage for dial-up access to the Internet via the PSTN. The PPP protocol has been defined by the Internet Engineering Traffic Forum (IETF) and a general description of the protocol is given in 'The point to point protocol, editor W. Simpson, July 1994, IETF RFC 1661'. A number of different datagram protocols or formats are provided for and these are allocated corresponding identifier numbers in IETF document RFC 1700, editor J. Reynolds, October 1994.

It will be appreciated that the different formats that are provided for by the PPP protocol have different quality of service (QoS) criteria. In current systems, this necessitates a separate channel with appropriate band width for each quality of service. This is wasteful in terms of traffic handling capacity, particularly where a single user has set up a

multiprotocol PPP session and will need to occupy a number of channels.

SUMMARY OF THE INVENTION

An object of the invention is to provide an improved system and method for the transport of PPP traffic over an ATM network.

According to one aspect of the invention there is provided a method of transporting point to point protocol (PPP) traffic over an asynchronous transport link, the method including encapsulating the traffic in minicells, and transporting said minicells in a single virtual circuit.

In a further aspect, the invention provides a method of trunking voice calls such that the multiple voice channels form a trunk group carried over a single point to point protocol (PPP) ATM trunk.

ATM adaptation layer two (AAL2) is a newly emerging standard which is being developed by the ITU-T for the transport of variable length packets over ATM networks. In this standard, a single AAL2 virtual circuit (VC) contains a multiplex of up to 256 individual data channels (commonly referred to as minichannels). Unlike traditional ATM, the packet payload size is arbitrary. A single AAL2 packet may contain between 0 and 64 octets of payload. We have found that arbitrarily large datagram structures can be transported via a packet segmentation and reassembly procedure that is also being defined as part of the standard. The AAL2 minichannel packets are multiplexed asynchronously into a single VC with a three byte packet header being used to identify the minichannel address and packet size.

We have found that AAL2 can be utilised to encapsulate PPP. Moreover, this encapsulation permits PPP to be used over any

transport link supporting ATM. PPP operates over a dedicated circuit which could be either an ATM virtual circuit (VC) or an AAL2 minichannel. With our arrangement and method therefore, a single VC is always sufficient to fully encapsulate the PPP protocol. The distinct protocols that are encapsulated into a PPP session can be transported within individual AAL2 minichannels, or multiple PPP sessions may operate within the same VC. The use of AAL2 reduces the number of VCCs required, simplifies the encapsulation of PPP, and improves the efficiency of the encapsulation. Further the use of AAL2 enables the use of both SVC and PVC encapsulation and allows either dynamic or static configuration of the channel assignments. Additionally, AAL2 offers the benefit that the multiplexing of the distinct protocols encapsulated in a PPP session may be performed in the protocol, PPP and AAL layers thereby providing flexible arrangements of network architectures.

BRIEF DESCRIPTION OF THE DRAWINGS

Embodiments of the invention will now be described with reference to the accompanying drawings in which:-

Figure 1 is a schematic diagram illustrating a point to point (PPP) protocol stack;

Figure 2 shows the format of a PPP frame;

Figure 3 illustrates the multiplexing of AAL2 minicells into ATM;

Figure 4 shows an improved PPP stack according to a first embodiment of the invention;

Figure 5 illustrates the segmentation of a datagram over a number of minicells;

Figure 6 shows an improved PPP stack according to a second embodiment of the invention; and

Figure 7 shows an arrangement for routing encapsulated PPP traffic.

DESCRIPTION OF PREFERRED EMBODIMENTS

Reference is first made to figures 1 and 2 which are introduced for explanatory purpose. Figure 1 illustrates the use of PPP to encapsulate datagrams over a dial up link via the PSTN/ISDN. The point to point protocol (PPP) provides a common standard for transporting multi-protocol datagrams over point-to-point links and is comprised of 3 main components. These are; a method for encapsulating datagrams from multiple protocols; a link control protocol for establishing, configuring (including authentication), and testing the data-link connection; and a family of network control protocols (NCPs) for establishing and configuring different network-layer protocols (NLPS). The NCPs and NLPs are allocated as pairs in PPP. Thus IP is one example of an NLP and its associated control channel, the NCP, is referred to as IPCP. Figure 1 shows an example protocol stack where PPP is being used to encapsulate datagrams over a dial up link via the PSTN/ISDN.

In PPP, the protocol field is used to identify the datagram type. A number of protocol identifiers have been defined covering the variety of supported LCPs, NCPs and NLPs. The full list of currently defined protocol identifiers is found in the above referenced IETF RFC 1700 document. Typically, for commonly used protocols two identifiers are assigned, one for a control channel (the NCP) and one for the data (the

NLP). There is a one-to-one relationship between assigned NCP/NLPs. For example IP data is assigned 0x0021 and the IP control channel (IPCP) of 0x8021. Although the protocol identifiers are two octets in length, their format has been defined such that high usage PPP datagrams (typically the NLPs) can be transmitted in an optional compressed one byte protocol field. To enable this, the assigned numbers are all defined such that the LSB of the most-significant octet is zero and the LSB of the least-significant octet is set to one. Thus it is always possible to distinguish between a full two-byte field and a compressed single byte field.

Referring now to figure 3, which is also included for explanatory purposes, this illustrates the multiplexing of AAL2 minicells. The AAL-2 adaptation layer was initially optimised to cope with the demands of low bit-rate communications, representing the increasing trend to greater voice compression. The adaptation layer is a multiplex of users in a single ATM connection, where each user's information is carried in a short packet, sometimes referred to as a minicell, with a header identifying the user channel together with ancillary control information.

By sharing the fixed length payload of the ATM cell between users, the compromise of trading cell assembly delay for bandwidth efficiency is overcome, this being a sacrifice which would be acute at low bit-rates and on expensive leased lines. The AAL-2 adaptation equipment performs a concentration function to ensure high utilisation, but can also limit the holdover delay of traffic when usage is low.

A further feature of minicells is that they may be of variable size, from 1 to 64 octets, to accommodate a wide variety of applications with minimal overhead. Additionally, a common methodology to segment and reassemble arbitrarily long datagram structures into the packet format is being standardised. We have found that AAL2 is suited to the

encapsulation of any datagram structure regardless of length and that the adaptation and packetisation can be tailored to the requirements of the service being supported and not fixed to the underlying transport layer.

The mapping to ATM cells is fully asynchronous and in fact quite independent of the length of an ATM cell. The boundary of minicells in the ATM cell payload is signified in every cell by a start field (STF), which specifies the offset, and the minicells form a self-delineating flow. The AAL-2 protocol format can thus be employed to carry minicells transparently over access systems which have fixed frame formats other than ATM cells, such as MPEG-2 transport stream. In fact minicells do not require an ATM cell or other frame structure at all, as it is possible to map the start field octet once every 48 octets (or other regular interval) with minicells in the intervening octet positions directly onto any physical bearer. The bearer identity can be used to regenerate the implicit ATM cell headers where the VCC needs to be transported over conventional ATM transmission.

The minicell is structured so that services of different types can be supported as service specific convergence sublayers (SSCS), all carried over the minicell common part sublayer (CPS) identically. The minicell header includes channel identity, length and user-to-user information (UUI), the latter allowing the functions of an SSCS to be specialised according to purpose. Examples of SSCS formats currently being defined are one to support voice and one to support data (including the functionality of SAR).

In a first embodiment of the invention illustrated in figure 4, there is a one to one static reference provided between the protocol identifier and the minichannel address. The 8 bit AAL2 address space provided

within the CID (channel identifier) field of the packet header can be increased, on an as-needed basis, by using the first octet of the packet payload. The extension of the address space in this way is possible since in this instance the PPP is designed to operate over a point-to-point link and thus there is no switching at the AAL2 layer, only in the ATM layer. The PPP overhead is minimised by only sending the additional octet when needed (i.e. for the infrequently used protocol identifiers in the range 0x0200 to 0xffff). Thus in this embodiment, we adopt a similar paradigm to the compressed address option available within PPP. To achieve this the least-significant octet of the protocol identifier is transmitted in the CID field of the packet header, and when necessary the most-significant octet is transported in the first octet of the packet payload. The LSB of the least-significant octet is used to indicate the presence or absence of the most-significant octet. A zero indicates no following most-significant octet; a one indicates a following most-significant octet. Thus for IP the user datagram (IP NLP = 0x021) would be indicated via the CID value of 0x20, whilst its control channel (ILCP NCP = 0x8021) would be indicated via a CID field of 0x21 followed by a first octet packet payload of 0x80, and the Link Control Protocol (LCP = 0xc021) would be indicated via a CID field of 0x21 followed by a first octet packet payload of 0xc0. There is no loss in generality in this approach of using the LSB of the CID field to indicate a further octet of addressing information since the PPP specification states that all protocol identifiers must be odd (to enable the optional compression to one byte) - thus this bit is not used as part of the PPP protocol address.

The LSB of the most-significant-octet (when used) provides a 1 bit parity check for error detection. Note that the LSB has no significance for the protocol identification. Further robustness against errors in this field is provided by the segmentation and reassembly SSCS error

detection capabilities which would operate over the complete set of payloads constituting a data frame.

The PPP information field is encapsulated into the AAL2 packet payload. A standardised SSCS Segmentation and Reassembly (SAR) function enables arbitrary length information datagrams to be transported. Further since AAL2 supports variable length packets there is never a requirement to transport the optional padding field of PPP. This improves efficiency by avoiding the need to transmit what are effectively empty packets.

An advantage of this method of PPP encapsulation is that it is possible (via the CID) to provide differing levels of QoS to the different protocols encapsulated into the session.

In a second embodiment of the invention, which exploits the limited number of protocol identifiers that are currently allocated: only seventy identifier numbers are currently assigned. Thus the 16 bits assigned to the protocol identifier field is significantly larger than needed. The 8-bit CID field of the AAL2 packet header is therefore completely sufficient to identify the current number of assigned identifiers, with significant further capability for future expansion. In this second aspect of the invention therefore we provide a preconfigured table of CID values. Each CID value is assigned one of the PPP assigned numbers. The assignment of CID values to PPP identifiers may be predetermined by a recognised standards procedure or could be set-up on a link-by-link basis via a management function or meta signalling.

In a further embodiment of the invention, use is made of AAL2's negotiation procedures (ANP) to establish and manage PPP sessions. Thus an AAL2 VC is set-up in the normal manner (via management or

signalling). On initialisation the VC will contain a single minichannel as normal- the ANP channel. To establish a PPP session the requesting entity initiates ANP to establish an LCP channel. ANP negotiates the establishment of a minichannel in the normal manner. The LCP channel can then establish and configure the PPP session in the normal manner. Once established the individual NLP/NCP channels are established in a similar manner to aspect 3 - with the exception that the ANP is used to set-up and tear down the individual minichannels.

An advantage of this embodiment is that a single VC may be used to establish multiple PPP sessions. A standard AAL2 relay function can be used to route the PPP sessions to different points within the network. Thus for example a home user might have two simultaneous PPP sessions established, one to a corporate intranet and one to a commercial ISP. Over the access network these two sessions are encapsulated into a single VC. At the interface to the core ATM network a relay function can be used to relay all PPP sessions to a particular route (say the ISP) in a single VC. Thus at all points in the network, the number of VCs used is minimised so as to reduce the associated signalling overhead.

A further advantage of this embodiment is that it has the ability to transport both PPP sessions and non-PPP session in the same VC. For example, a voice call can be sent in the same channel as a PPP encapsulate Internet session thus ensuring VC signalling and establishment is minimised and optimising the utilisation of bandwidth within a VC.

Figure 5 illustrates the segmentation of long datagrams over a number of minicells. The PPP information together with the protocol identifier is mapped into the payload of a datagram which is provided with a trailer

comprising UUI, CPI, LI and CRC fields. The datagram payload is then segmented into 63 byte portions which are mapped into the minicell payload, this being provided with a header comprising CID, LI, UUI, CRC and MID fields. The LSB of the UUI field provides an indicator of the continuation/end of a segmented datagram

A further extension to this embodiment can be achieved by extending the SSCS function that performs the SAR to include the ability to multiplex at the SSCS layer. Thus, multiple sources can be multiplexed into a single AAL2 minichannel. This enables a choice to be made as to how the individual PPP channels are encapsulated into AAL2 (via multiplexing at the SSCS or CPS layer). Thus a full PPP session could be encapsulated into a single AAL2 minichannel enabling the number of simultaneous PPP sessions within a single VC to be maximised, or a separate minichannel could be used to encapsulate a single channel of the PPP session only. Typically one might wish to allocate an AAL2 channel to each level of priority within the PPP - thus all delay sensitive channels might be encapsulated into a single CID and all delay insensitive channels into a further CID. The ability of AAL2 to prioritise minichannels can then be used to ensure the delay sensitive services are subjected to minimum delay. The extended PPP2 stack for this embodiment is shown in figure 6.

As discussed above, the AAL2 minichannels form an asynchronous self-delineating stream that is carried within ATM payloads. Thus the ATM cells essentially perform a transport function only. Therefore AAL2 minichannels can be carried directly over any regular transport structure (for example PEG-2 TS frames or DMA time slots) without the need to carry ATM. Thus, by using our arrangement, the use of PPP2 can be extended to cover any regular transport structure used in the

access network. A relay point at the interface to the ATM core network can be used to readapt the minichannels into and out of ATM cells.

Referring now to figure 7, this shows an arrangement for transporting encapsulated PPP traffic over an asynchronous link and for trunking voice calls such that the multiple voice channels form a trunk group carried over a single point to point protocol (PPP) ATM trunk. In this arrangement, PPP sessions can be set up between work stations 61 via ethernet switches 62, network adapters 63 and an ATM transport network 64. H323 gatekeepers 65 are coupled one to each ethernet switch 62, and each network adapter is coupled to an ISDN call handler 66. The figure illustrates the establishment of a PPP session between two work stations 61a and 61b.

The H323 standard provides three types of signalling channel, these being indicated on figure 6. An RAS channel enables registration, authentication and status to establish that the user is authorised for the H323 service. A Q931 ISDN signalling channel is set up to the ISDN call handler to effect calls. When the user makes a call, the third signalling channel is established end to end between the participating work stations or terminals and is used to negotiate the connectivity of the two terminals, to establish the particular coding to be employed and to support the voice channel end to end. The H245 control channel is intercepted to negotiate PCM voice and to apply compression and silence suppression. The voice channel provides a trunk link between the network adapters. Over this trunk link, multiplexing is used to fill the AAL2 cell and thus maximise capacity.

The arrangements and method described above provide for flexibility in multiplexing. In particular, multiple PPP sessions can be multiplexed on the same VC, or PPP sessions can be multiplexed with other services

on the same VC. There can be on PPP session per CID , or multiple PPP sessions per CID, or multiple CIDs per PPP session. Other combinations or variants will be apparent to the skilled worker.

CLAIMS:

1. A method of transporting point to point protocol (PPP) traffic over an asynchronous transport link, the method including encapsulating the traffic in minicells, and transporting said minicells in a single virtual circuit.

2. A method as claimed in claim 1, wherein said traffic originates from a number of users, and wherein said minicells are multiplexed within the virtual circuit.

3. A method as claimed in claim 2, wherein said minicells are of variable length.

4. A method as claimed in claim 3, wherein said minicells form the payload of fixed length asynchronous transfer mode (ATM) cells.

5. A method as claimed in any one of claims 1 to 4, wherein the PPP traffic incorporates protocol identifiers, and wherein there is a one to one relationship between each said protocol identifier and a respective minicell address.

6. A method as claimed in claim 5, wherein the PPP traffic comprises the ATM packet payload, wherein each said packet incorporates a packet header having a channel identifier field, and wherein the least significant octet of the protocol identifier is transmitted in said channel identifier field.

7. A method as claimed in claim 6, wherein the channel identifier field incorporates an address space, and wherein the first

octet of the payload is selectively available to accommodate the most significant octet of the channel identifier field .

8. A method as claimed in claim 7, wherein the least significant bit of the least-significant octet of the channel identifier field is used to indicate the presence or absence of the most-significant octet.

9. A method of trunking voice calls such that the multiple voice channels form a trunk group carried over a single point to point protocol (PPP) ATM trunk.

10. Apparatus for transporting point to point protocol (PPP) traffic over an asynchronous transport link, the apparatus including means for encapsulating the traffic in minicells, and means for transporting said minicells in a single virtual circuit.

ABSTRACT

TRANSPORTING MULTIPROTOCOL DATAGRAMS

Point to point protocol (PPP) traffic is transported over an asynchronous transport link by encapsulating the traffic in AAL2 minicells and transporting the minicells in a single virtual circuit. Minicells from a number of users can be multiplexed in the same virtual circuit.

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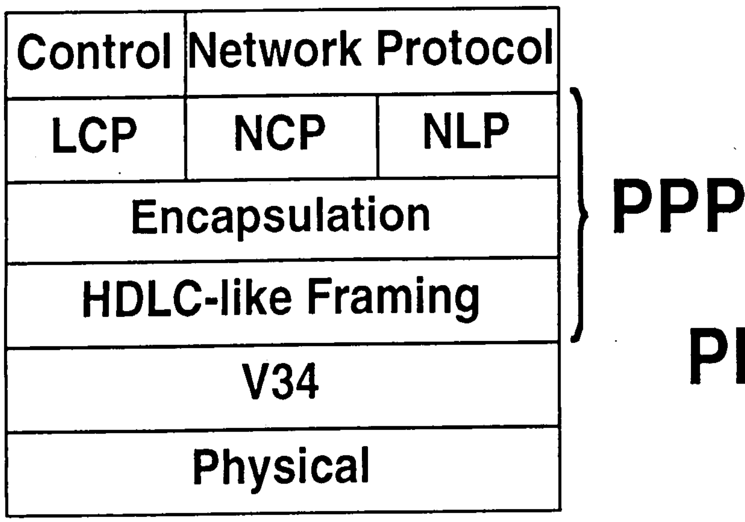


Fig.1
(Prior Art)

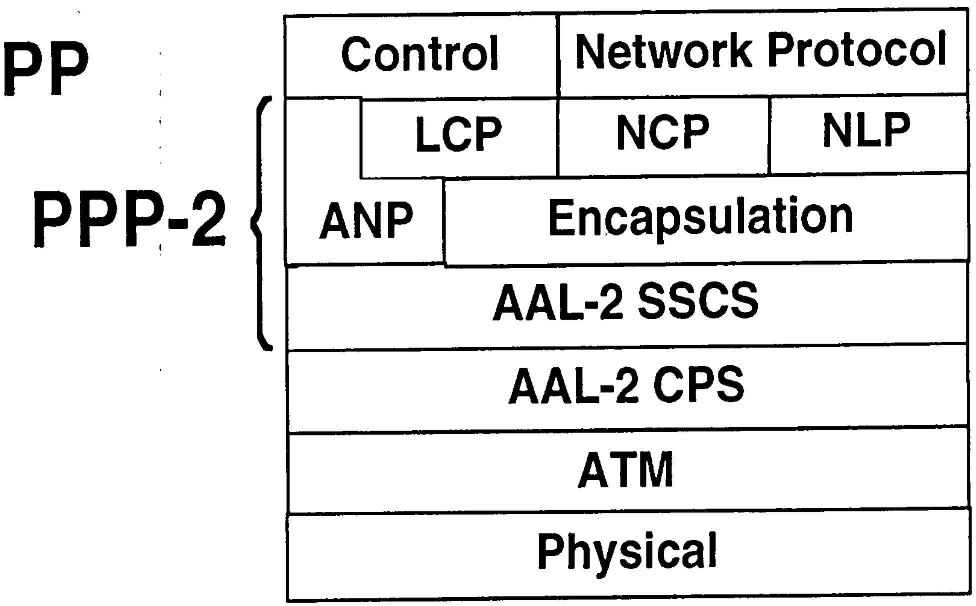


Fig.4

LCP	Link Control Protocol
NCP	Network Control Protocol
NLP	Network Layer Protocol

Protocol Identifier (8 or 16 bits)	Information	Optional Padding

Figure 2 PPP Format

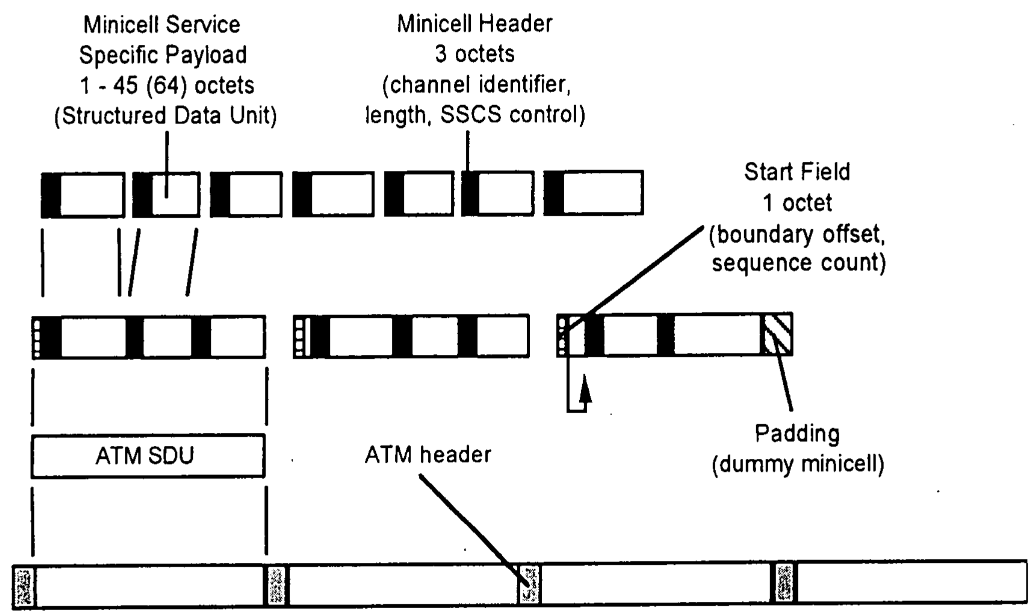

Minicell Service
Specific Payload
1 - 45 (64) octets
(Structured Data Unit)
Minicell Header
3 octets
(channel identifier,
length, SSCS control)
Start Field
1 octet
(boundary offset,
sequence count)
ATM SDU
ATM header
Padding
(dummy minicell)

Fig.3

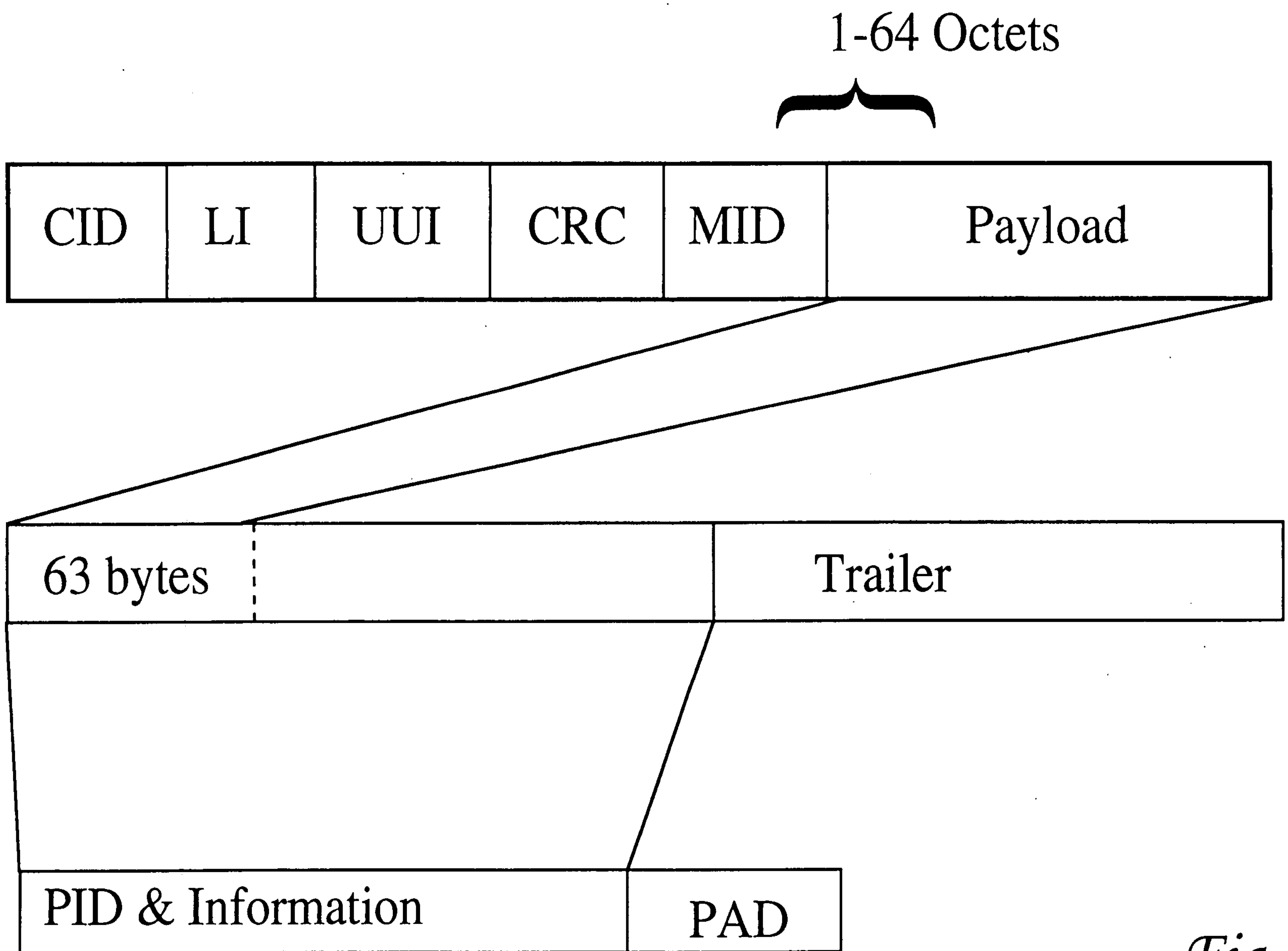

1-64 Octets
CID
LI
UUI
CRC
MID
Payload
63 bytes
Trailer
PID & Information
PAD

Fig.5

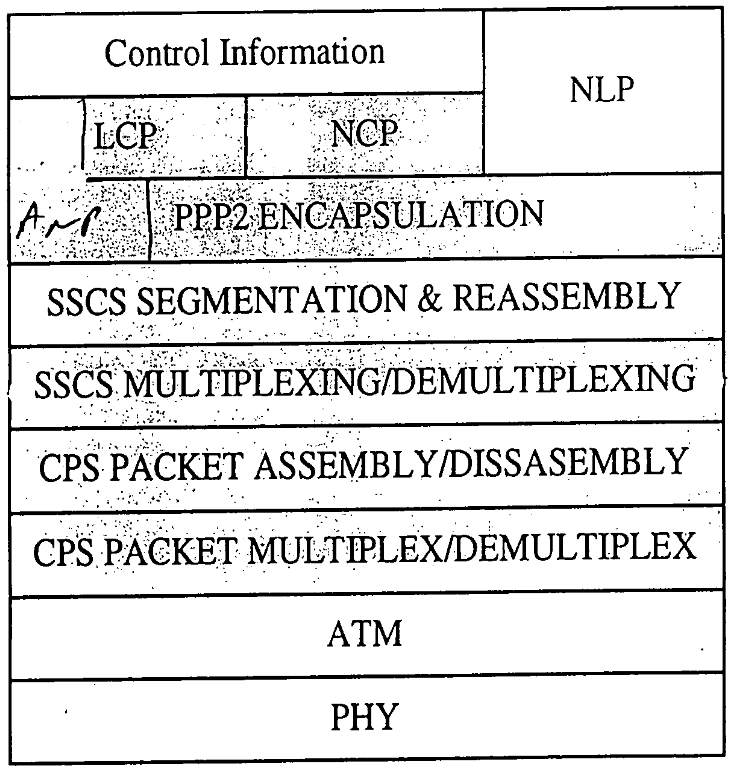
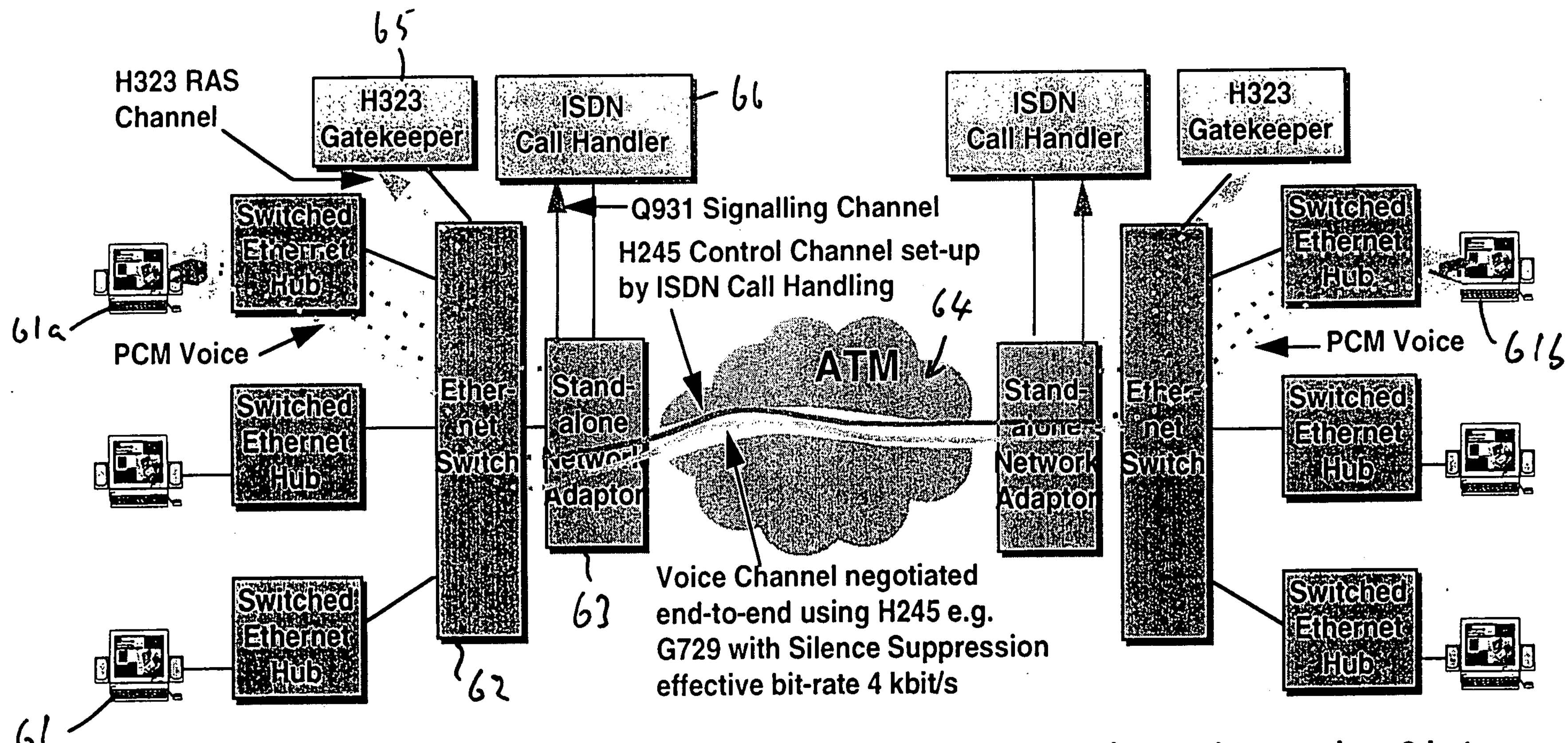


Figure 5 ~~Extended PPP2 Stack~~



PPP-2 is the IETF point-to-point protocol revised to utilise an AAL-2 VC

PPP-2 eliminates IP headers and compresses RTP/UDP to 3 bytes

A single PPP-2 VC can multiplex multiple H.323 calls

10 byte G729 voice packet requires 3 byte minichannel and 3 byte RTP/UDP headers

Effective ATM capacity/call 6.4 kbit/s

Toll Quality Voice (MOS 4.0, global max. delay 150 msec)

Fig 7

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